

Physicochemical Studies of Bore Wells Water of Different Places in Chennai, India

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Physicochemical studies such as pH, chemical oxygen demand, total and permanent hardnesses and hardness due to magnesium, chloride, sulphate, phosphate and nitrate contents, total dissolved solids and conductivity of various bore well waters were carried out for thirty samples collected at different parts of Chennai especially in the central region during April 2004 and their water qualities were assessed.

Key Words: Physicochemical studies, Bore well water, Chennai.

INTRODUCTION

The southern state of India, Tamil Nadu, received very little rainfall in the past four to five years. This resulted in severe drought and perennial drinking water problem. The state capital, Chennai, located in the extreme north of the state, used to get its drinking water supply from the prominent reservoirs around it such as Cholavaram, Red Hills, Chembrambakkam and Poondi lakes. As these lakes got dried up in recent years, people started digging bore wells several feet in depth. The quality and quantity of water are found to vary from place to place.

Bore well water is the underground water that comes as the seepage of surface water and is held in sub-soil and rocks. Bore well water is expected to be good in quality and less polluted. The use of fertilizers, pesticides and insecticides in rural areas, lime, bleaching powder, septic tanks, refuse dumps, etc., in urban areas are the main sources of soil and underground water pollution.

Several reports have appeared on the analysis of bore well water in the rural areas of Tamil Nadu¹ and in other states²⁻⁵. In order to assess the quality of various bore well waters in Chennai, we have carried out a systematic physicochemical study on various samples drawn from different parts of the city.

EXPERIMENTAL

About thirty bore well water samples from different areas in the city were collected in brown glass bottles with necessary precautions⁶.

AR grade chemicals and double distilled water were used for the preparation of various solutions required for analysis. The factors considered for the studies are pH, chemical oxygen demand (COD), hardness (total, permanent and temporary hardnesses and hardness due to magnesium), qualitative studies for the detection of ions, total dissolved solids, conductivity and UV absorption studies for the presence of any organic substances⁷.

The parameters such as pH, COD, TDS were determined by standard manual methods. Hardness of water was estimated by complexometric titrations⁸ using EDTA. UV spectra were recorded on Hitachi UV-Vis spectrometer using a pair of matched quartz cells of path length 1 cm.

RESULTS AND DISCUSSION

The physicochemical data for the bore well water samples collected in April 2004 are presented in Tables 1 and 2. The analytical data of most of the samples vary with the places of collection, which may be attributed to the differences in soil composition and the extent of land pollution⁹.

The pH of water is an important parameter to assess its quality as drinking water. Low pH, *viz.*, below 6.5 corrodes metal pipes, resulting in the release of toxic metal compounds. The pH of the water samples in the present study was found to range from 6.9 to 8.6, which almost lies within the range prescribed by IS: 10500-1991, *viz.*, 6.5–8.5. Waters having pH beyond this limit affect mucous membrane.

The chemical oxygen demand of all the samples lies below 150 mg/L compared to the maximum permissible limit, *viz.*, 250 mg/L, indicating the presence of chemically oxidizable substances in low concentrations. The described limit of the total dissolved solids is 500 mg/L and the permissible limit is 2000 mg/L in the absence of alternate source. According to WHO and Indian Standards, TDS values should be less than 500 mg/L for drinking water. In the present study, with some exception, the values of TDS for most of the samples ranged from 30–1660 mg/L which lies in the range suggested by WHO and Indian Standards^{9, 10}.

All the hardness values are expressed in terms of mg/L (*i.e.*, ppm) of CaCO₃ as per standard conventions. The total hardness of the bore wells water varied from 60–2600 mg/L (described limit is 300 mg/L and the permissible limit is 600 mg/L in the absence of alternate source). Most of the waters collected have their total hardness above the permissible limit, *viz.*, 600 mg/L of CaCO₃. Water samples at Loyola College just touch the maximum limit, whereas the samples from Kodambakkam, Gillnagar, NGO Colony, Kolathur, etc., have their hardness much above the maximum limit. There are areas like Sterling Road, Valluvarkottam Road, Nungambakkam Village Road, Sakthi Nagar, Sowrashttra Nagar, Choolaimedu, West Jafferkhanpet, Saidapet, etc., having their total hardness almost closer to the lower described limit, *viz.*, 300 mg/L of CaCO₃. Hence, these waters are relatively soft and could be used even as drinking water after the required biological assay.

TABLE-1
ANALYTICAL DATA FOR BORE WELL WATER IN CHENNAI, TAMIL NADU, INDIA

Sample No.	Sample places	pH	COD mg/L	Total hardness mg/L of CaCO ₃	Permanent hardness mg/L of CaCO ₃	Hardness due to Mg ²⁺ mg/L of CaCO ₃	Chloride mg/L	TDS mg/L	Specific conductivity (Sm ⁻¹)	λ_{\max} (nm)	A _{max}
1	Loyola College (North)	7.68	15	819.6	804.5	770.0	312	754	4.39	—	—
2	Loyola College (Central)	7.81	50	812.1	774.5	430.1	302	779	3.78	—	—
3	Loyola College (South)	7.96	50	789.5	763.2	439.9	290	749	4.41	—	—
4	Sterling Rd, 1st Cross St	8.03	0	274.4	190.5	170.6	204	232	1.95	—	—
5	Sterling Rd, 2nd Cross St	8.18	10	180.5	120.3	112.0	135	226	1.68	—	—
6	Shenoy Nagar	8.06	30	323.3	225.6	214.4	241	396	2.68	226	0.27
7	Valluvarkottam Rd	8.59	30	60.2	45.1	14.7	44	80	2.97	—	—
8	Appu St., Nungambakkam	8.43	50	116.5	109.0	92.9	156	178	2.67	—	—
9	B.E. Colo Kodambakkam	7.33	0	1594.0	1552.7	1539.5	412	1279	7.63	—	—
10	Village Rd	8.41	80	150.4	142.9	102.6	112	192	1.85	227	0.37
11	Showrashtra Nagar, 8th St	7.87	50	669.2	612.8	576.7	393	607	3.54	—	—
12	Padaiyappa Nagar, 2nd St	8.01	30	454.9	368.4	305.7	340	471	3.21	228	0.40
13	Sakthi Nagar, 2nd St	7.93	40	394.8	312.0	263.9	234	386	2.73	233	0.40
14	Arthreyapuram, 2nd St	7.96	150	575.2	530.1	440.2	229	432	3.43	231	0.40
15	Gill Nagar 1st Cross St	7.38	80	1718.1	1710.6	1564.0	884	1425	8.30	230	0.40

TABLE-2
ANALYTICAL DATA FOR BORE WELL WATER IN CHENNAI, TAMIL NADU, INDIA

Sample No.	Sample places	pH	COD mg/L	Total hardness mg/L of CaCO ₃	Permanent hardness mg/L of CaCO ₃	Hardness due to Mg ²⁺ mg/L of CaCO ₃	Chloride mg/L	TDS mg/L	Specific conductivity (Sm ⁻¹)	λ_{\max} (nm)	A _{max}
16	Gill Nagar 3rd Cross St	7.78	30	605.3	586.5	576.7	352	503	3.82	—	—
17	NGO Colony 1st Main Rd	7.08	90	2675.0	2389.3	1912.8	947	2344	13.25	—	—
18	Sowrastra Nagger 8th St	8.12	70	368.4	315.8	195.5	275	437	2.21	—	—
19	Kalyanapuram	8.10	20	477.5	357.2	325.2	356	561	3.94	—	—
20	Choolaimedu	7.97	65	315.8	304.5	156.4	186	340	2.62	241	0.40
21	Ambattur	8.24	60	176.5	170.9	162.1	132	173	0.68	227	0.35
22	Jagannath Rd, Chetpet	8.05	0	114.8	103.6	76.5	86	178	1.96	—	—
23	P.N., St. West Jafferhanpet	8.12	35	353.4	248.1	239.5	263	410	4.20	226	0.19
24	R.K., St, West Jafferhanpet	8.10	0	78.4	67.2	65.5	105	149	2.19	—	—
25	S.M., St, Saidapet	7.14	0	148.5	134.5	128.4	111	174	1.88	233	0.40
26	V..S. Mudali St, Saidapet	8.59	50	56.4	48.9	48.9	41	76	2.14	231	0.35
27	Jeenis Rd, Saidapet	8.26	115	142.9	131.6	106.2	106	186	1.65	227	0.38
28	Kolathur	6.95	85	902.3	845.9	767.3	274	640	5.62	—	—
29	Nandhambakkam	7.27	90	597.8	496.3	415.4	346	544	3.76	239	0.40
30	Patteravakkam	7.91	60	778.2	710.6	537.6	381	852	2.99	226	0.31

Most of the water samples contained appreciable amounts of chloride as evidenced by their Volhard's method of determination and very little amount of sulphate. Nitrates and phosphates are almost nil or negligible to be detected. The reason for the absence of phosphate, nitrate in urban bore well water may be attributed to less use of fertilizers and pesticides in the city. The chloride content of the samples was found to be much high in magnitude and in accordance with its hardness and TDS. Natural water contains low chlorides in the range 50 to 145 mg/L. The findings indicate that about ten samples, out of thirty samples analyzed, have chloride contents below the permissible limit for drinking water, prescribed by Indian Standard¹⁰.

The specific conductivities of the samples are found to be directly related to their hardness and total dissolved solids. For example, the water sample collected at NGO Colony has maximum specific conductivity and dissolved solids. Similarly, water samples having higher dissolved solids are those collected from BE Colony, Kodambakkam, Valluvarkottam Road, Kalyanapuram and Kolathur, which are found to have appreciable specific conductivity.

The UV spectra of some samples showed narrow peaks around 225 to 240 nm with absorbance maxima in the range 0.20 to 0.40 which may be attributed to the presence of some micro-organisms or organic residues.

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REFERENCES

1. N. Raman and A. Murugesan, *Asian J. Chem.*, **13**, 995 (2001).
2. S. Ghoshal, S.S. Dedalal and S.C. Lahiri, *J. Indian Chem. Soc.*, **81**, 318 (2004).
3. D.M. Vairagade, H.D. Juneja, R.T. Jadhav and L.J. Paliwal, *Asian J. Chem.*, **12**, 101 (2000).
4. A.K. Rana, M.J. Kharodawala, J.M. Patel, R.K. Rai, B.S. Patel and H.R. Dabhi, *Asian J. Chem.*, **14**, 1209 (2002).
5. B.H. Mehta and M.B. Mehta, *Asian J. Chem.*, **12**, 122 (2000).
6. E. Brown, M.W. Skovgtsd and M.J. Fishman, Method for collection and analysis of water samples for dissolved minerals and gases, Book 5, Chapter A1, Washington DC, Superintendent of Documents, US Government Printing Office (1970).
7. N. Manivasagam, Physico-Chemical Examination of Water, Sewage and Industrial Effluents, Pragati Prakashan, Meerut (1984).
8. A.I. Vogel, Text Book of Quantitative Inorganic Analysis, 4th Edn., ELBS, London (1978).
9. S.S. Dara, Environmental Chemistry and Pollution Control, S. Chand & Company, New Delhi p. 356 (2004).
10. The Gazette of India, Extraordinary Part-II, **3**, 11 (1991).